NASA TECH BRIEF

Program Computes Equilibrium Normal Shock and Stagnation Point Solutions for Arbitrary Gas Mixtures

This program computes solutions for flow parameters in arbitrary gas mixtures in the following situations: (1) behind a normal shock; (2) behind a reflected normal shock; (3) for in-flight stagnation conditions; and (4) for shock-tube stagnation conditions.

With the advent of hypervelocity vehicles and test facility vehicles and test facilities, it has been necessary in the solution for normal shock and stagnation point conditions to include the effect of the complex chemistry associated with high-speed phenomena.

Since the equilibrium properties of high temperature air are well known, there have been numerous solutions for normal shock parameters in air including stagnation point solutions. Methods of solution range from computer use of polynomial fits of equilibrium thermodynamic data to hand calculations.

Input required for the program is described and required physical constants for computations involving 27 species of the argon, nitrogen, oxygen, and carbon genre are tabulated. Cases may be run in sequence and any or all of the aforementioned flow configurations may be included in a single case.

Program output parameters are pressure, density, enthalpy, entropy, compressibility, temperature, and mole fractions of the included chemical species which may number up to 30. For traveling normal and reflected shocks, the flow velocity and reflected shock velocity are also presented as output.

Equilibrium flow calculations are carried out by utilizing a free-energy minimization technique coupled with the steady-flow conservation equations and a modified Newton–Raphson iterative scheme. Chemistry up to second ionization is included.

Notes:

1. The program is written in Fortran IV language for use on the IBM 7094 computer.
2. Inquiries concerning this program may be made to:

   COSMIC
   Computer Center
   University of Georgia
   Athens, Georgia 30601
   Reference: B67-10509

Patent status:

No patent action is contemplated by NASA.

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